AEDC-TSR-78-P50 NOVEMBER 1978



VERIFICATION TEST OF THE AEDC HIGH ALPHA ROLL DYNAMICS SYSTEM

J. A. Collins ARO, Inc., AEDC Division A Sverdrup Corporation Company Propulsion Wind Tunnel Facility Arnold Air Force Station, Tennessee

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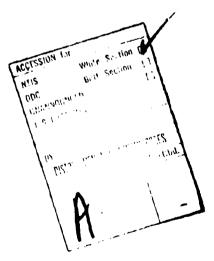
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	Roll Damping st	in						
	Basic Finner co	ontroller						
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and a microprocessor-based controller for the turbine/clutch/brake sequencing and for interfacing with the PWT computer system. \sim



APBC

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NOMENCLATURE

At.F1	indicated pitch angle of strut support, deg
At 1 M	Model angle of attack, deg
CBAR	A reference length of the model upon which aerodynamic coefficients are based (CBAR = D), 4.50 in.
C BOX 6	Manual input number six
CLM	Pitching-moment coefficient in the body axis, pitching moment/ $(Q)(S)(D)$
CLN	Yawing-moment coefficient in the body axis, vawing moment/(Q)(S)(D)
CLNC	Corrected yawing-moment coefficient in the body axis, corrected vawing moment/(Q)(S)(D)
CLNO	Static vawing-moment coefficient at P = 0
CLNU	Magnus-moment spin derivative coefficient, $300N/3(PD/2V)$, radian ⁻¹
(LJ)	Rolling-moment coefficient at P = 0
CLP	Roll-damping coefficient from on-line data reduction program, $\Im\{1.TOT/(Q)(S)(D)\}\Im(PD/2V)$, radian ⁻¹
CLP1	Roll-damping coefficient from the final reduction of the differential correction data reduction off-line method, radian ⁻¹
CN	Normal-torce coefficient in the body axis, normal force/(Q)(S)
CONF	Configuration number
cY	Side-torce coefficient in the body axis, side force/(Q)(S)
CAC	Corrected side-torce coefficient in the body axis, corrected side torce/(Q)(S) $$

CYO Side-force coefficient at P = 0

CYP Magnus-force spin derivative coefficient, $\partial CY/\partial (PD/2V)$,

radian⁻¹

B Model body dlameter, 4.50 in.

DATE Date of data acquisition

DAY Day (of year) of data acquisition

PM Mach number tolerance

ERCODE Error code

FIN Fin cant angle, deg

FN Balance axis net normal force, 1b

FNG Balance axis gross normal force, 1b

FY Balance axis net side force, 1b

FYG Balance axis gross side force, 1b

HR Hour of data acquisition

IX Model moment of inertia, slugs-ft²

J Manual input indicating number of data samples to average

L/D Model length to diameter ratio, 10.00

1.0 Static rolling moment at P = 0, ft-lb

 $L0_{R}$ Bearing static rolling moment at P = 0, ft-1b

1.3' Roll-damping moment, ft-lb-sec/radian

 ${\rm LP}_{\rm R}$ Bearing roll-damping moment, ft-lb-sec/radian

LTOT Total rolling moment, ft-lb

M Mach number

MB Set point Mach number

MM Net pitching moment about the moment reference center, in.-1b

MN Balance axis yawing moment transferred to the moment

reference center, in.-1b, or minute of data acquisition

MODE Data acquisition mode

P, PHI Model spin rate, radian/sec

F1 Free-stream static pressure, psia

PART Fart number: sequential number for referencing data.

One part number per ptich pelar

PCA-X Test section plume pressure-A system, psfa

PCB-X Test section plenum pressure-B system, psfa

PD/2V Spin parameter, radian

PE Tunnel diffusor pressure, psfa

PHIL initial roll position, radian or pitch sector indicated

roll angle, deg

PHI Model roll angle, deg

PHI, P Model roll rate, radian/sec

PHI Model angular acceleration, radian/sec²

PHIL Initial roll rate, radian/sec

PM Hygrometer mixture pressure, psfa

POINT Point number: sequential indexing number for referencing

data with a part number

POR Average tunnel wall porosity, percent of wall area open

to test section plenum

PROJECT Project number

PROS DATE Date of data processing

PSS Model steady-state spin rate, radian/sec

PSSD/2V Steady-state spin parameter, radian

PT Free-stream stagnation pressure, psfa

PTA-X Free-stream stagnation pressure-A system, psfa

PTB-X Free-stream stagnation pressure-B system, psia

Free-stream dynamic pressure, psf

 $R \times 10^{-6}$ Unit Reynolds number, 1/tt

RED x 10-6 Free-stream Reynolds number based on model diameter

REL x 10⁻⁶ Free-stream Revnolds number based on model length

RES Side-torce residual, CY (Hinear fit) - CY (data)

RPM) Model rotation rate - primary system, revolutions per

minute

S A reference area of the model upon which aerodynamic

coefficients are based, 0.110

SAMPLE Data sample identification number

SC Second of data acquisition

SC x 100 Tunnel specific humidity

SCHED Tunnel wall porosity schedule

SPIN Model spin direction, I indicates clockwise looking

upstream, 2 indicates counter-clockwise

SUMR Sum of side-force residuals squared

TBP Brake pad temporature, °F

TDP Hygrometer dewpoint temperature, °F

TEST Test number

TIME Time (averaged) corresponding to averaged data

TIME1 Initial time, sec

TPR Tunnel pressure ratio, PT/PE

TT Tunnel total temperature. "F

TTA-X Free-stream stagnation temperature-A system, °F

TTB-X Free-stream stagnation temperature-B system, °F

V Free-stream velocity, it/sec

WA	Test section wall angle, deg
WIND-OFF	Wind-off part and point number
XP	Distance from the model nose to the moment reference point (see Fig. 1), calibers
xcr	Center of pressure along the X-axis referenced to model nose
YCP	Center of pressure along the Y-axis reference to model nose
	Prefix indicating uncertainty in the value of a parameter (in the units of the parameter)

1.0 INTRODUCTION

The work reported herein was conducted by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), under Program Element 65807F, Control Number 9 RO2-05-8. The project monitor for AEDC/DOTR was Hr. A. F. Money. The results were obtained by ARO, Inc., AEDC Division (a Sverdrup Corporation Company), operating contractor for the AEDC, AFSC, Arnold Air Force Station, Tennessee. This test was conducted in the Aerodynamic Wind Tunnel (4T) of the Propulsion Wind Tunnel Facility (PWT), August 23, 1978 under ARO Project Number P41C-20 and was in support of Technology Project V32A-R4.

The primary objectives of the wind tunnel program were to evaluate the new AEDC High Alpha Roll Dynamics System for large models and obtain scaling parameter information. Data were obtained at Mach numbers 0.22 through 1.15 for a Reynolds number per ft range of 0.69 x 10⁶ through 2.50 x 10⁶, at angles of attack -5 to 25 deg, and spin rates up to approximately ten thousand RPM. The model configurations (L/D of 10, D = 4.5 in.) included the Basic Finner and the Modified Basic Finner. The test data were compared with the test results obtained in the PWT Tunnel 4T (ARO Project Number P41C-AOA) and the von Karmán Gas Dynamics Facility (VKF) Tunnel A (ARO Project Number V41A-ABA) during 1976 utilizing the same configurations on a smaller scale (D = 1.8 in.).

A copy of the final data is on file on microfilm at AEDC. Requests for these data should be addressed to AEDC/DOTR, Arnold Air Force Station, Tennessee 37389.

2.0 APPARATUS

2.1 TEST FACILITY

Tunnel 4T is a closed loop, continuous flow, variable-density tunnel in which the Mach number can be varied continuously from 0.1 to 1.3 and can be set at discrete Mach numbers of 1.6 and 2.0 by placing nozzle inserts over the permanent sonic nozzle. The stagnation pressure can be varied from 400 to 3,400 psfa at a majority of the Mach numbers. The test section is 4-ft square and 12.5-ft long with perforated, variable porosity (0.5- to 10-percent open) walls. It is completely enclosed in a plenum chamber from which the air can be evacuated, allowing part of the tunnel airflow to be removed through the perforated walls of the test section. The model support system consists of a sector and sting attachment which has a pitch angle capability of -7.5

Jenke, Leroy M. "Experimental Roll-Damping, Magnus, and Static-Stability Characteristics of Two Slender Missile Configurations at High Angles of Attack (0 to 90 Deg) and Mach Numbers 0.2 through 2.5," AEDC-TR-76-58, July 1976.

to 28 deg with respect to the tunnel centerline and a roll capability of -180 to 180 deg about the sting centerline. A more complete description of the tunnel may be found in the Test Facilities Handbook².

2.2 TEST ARTICLE

2.2.1 Mode 1

Two aluminum models (Fig. 1) were designed and tabricated by the AEDC for this test. One of them is commonly referred to as the Basic Finner. It consists of a cone-cylinder with four rectangular fins. Overall model length is ten calibers, the cone half-angle is 10 deg, and the fins are approximately one caliber in chord and have an overall span of three calibers. A set of fins with a cant angle of 2.5 deg was tested. Another configuration, the Modified Basic Finner was also tested. It utilized the same body but used an ogive nose and four fins with a trapezoidal planform and zero cant angle.

The models were dynamically balanced in roll (±1-in. gm) at the "...) so that there would be no vibrational loads on the balance. The moments of inertia of the model were measured and are considered to be accurate to ±0.5 percent. Installation of the Basic Finner Configuration in 4T is sketched in Fig. 2a; a photograph of the Modified Basic Finner is presented in Fig. 2b.

2.2.2 Test Mechanism

The AEDC High Alpha Roll Dynamics test mechanism for large models (Fig. 3) is a sting mounted, four-component balance corneiform design about the sting) with a shell mounted on ball bearings. A pneumatically driven turbine is mounted near the aft end of the sting. The turbine which can be engaged to the model mounting shell with a pneumatic clutch, spins the model to the desired speed, and then is disengaged with the clutch to allow the model to spin freely on the ball bearings. The turbine will produce a starting torque of 90 in.-lb and a developed torque of approximately 140 in.-lb. A pneumatically-operated brake is mounted immediately aft of the model mounting shell aft of the balance. The brake will provide a static braking moment of 170 in.-lb and a dynamic braking moment of 105 in.-lb. The rotational speed, roll position, and roll direction are computed from the electrical pulses produced by a ring with alternating reflective and nonreflective surfaces passing three internally mounted infrared-emitting diodes and phototransistors. The mechanism is designed to operate under normal-force loads up to 1200 lb (6000 RPM max) and axial-force loads of 150 lb and at maximum spin rates of approximately 20,000 RPM (600 lb normal-force load max). Maximum side force is 240 lb and is independent of spin rate.

Test Facilities Handbook (Tenth Edition). "Propulsion Wind Tunnel Facility, Vol. 4," Arnold Engineering Development Center, May 1974.

2.2.3 Controlier

Programmable control of the model status and the data acquisition computer was accomplished by a microprocessor-based controller (Fig. 4a). This control system, as diagrammed in Fig. 4b, automatically releases the model, spins it to a specified rate, disengages and stops the turbine, initiates and stops the data acquisition computer, applies the brake, and tells the model attitude computer to move the mechanism to the next angle of attack. This makes the system more productive and is especially useful in data acquisition for models which have spin down times of a few seconds (e.g., models with large fins and small inertias). A valuable feature of this control system is the programmed monitoring of the turbine/clutch/brake to avoid mechanism damage.

2.3 FEST INSTRUMENTATION

Model forces and moments were measured with the new AEDC four-component, force-type, strain-gage balance. The small outrigger side beams of the balance were used to obtain the sensitivity required to measure small side loads while maintaining adequate balance stiffness for the larger pitch loads. A normal-force to side-force capability of five was achieved for a 1200-1b normal force loading. The transfer distance to the model moment reference was measured with a precision of ±0.005 in.

A model grounding strip was provided on the sting to detect modelsting fouling. Brake pad temperature measurement was made with an ironconstantan thermocouple.

The sting pitch and roll angles were sensed by a synchrotransmitter. Sting deflections due to loads in the normal force and side force planes were calibrated before model entry into the tunnel. During testing, the model attitude was obtained from a combination of the sting attitude and sting-balance deflections under aerodynamic loads.

All steady-state measurements were sequentially recorded by an online computer system in which the data were reduced to engineering units. All transfent data samples were averaged over a defined interval by the on-line computer system which then reduced and tabulated a specified number of averaged samples. All balance measurements and the model attitude were paralleled to a real-time digital data acquisition system. Balance static and dynamic limits were continually monitored during testing.

3.0 TEST DESCRIPTION

3.1 TEST CONDITIONS AND PROCEDURES

The test conditions are presented as follows,

31	$\kappa \propto 10^{-6}$	rt, psta	$(v_{\alpha})^{\alpha}v$	PA, Peta	Q. Pad	V, tt/sec
$\Omega_{x,x}^{-\infty} =$	0.28	415	8.1	401	1.1	.250
0.22	2.00	0140	118	1040	108	205
0.60	0.70	4 10	9(1	14.5	86	667
0,60	1, 10	639	4.1	540	1 10	660
0,60	2,50	1650	109	1.92	327	679
0.90	1,40	549	91	1.11	185	964
0.90	2,00	1008	96	596	3.38	965
0.90	2,50	1286	103	151	411	9.75
1, 18	2.00	954	96	4.20	188	1131

and a test summary showing all configurations tested and the variables for each is presented in Table 1.

Prior to the test period, the balance was loaded with known weights to check the balance output. Weight tates were obtained and the model attitude sensor readings were compared with the calibrations. Before the tunel was brought on line, all high pressure gas requirements for the turbine/clutch/brake were regulated. When the test conditions were established, the controller automatically initiated the model positioning to the first desired angle of attack, the spin sequence, data acqubittion, and model movement to the next programmed angle of attack.

3.2 DATA REDUCTION

The model gross forces and moments were corrected for model weight, and the indicated model attitude was corrected for balance siting deflections. Model corrected force and moment measurements were reduced to coefficient form in the body axis. The reference length, D, and the reference area, S, are given in the Nomenclature. For convenience, the moment reference center is illustrated in Fig. 1.

The one degree of freedom equation of motion in roll can be written as

$$(1X)(PHI) - LTOT \tag{1}$$

where LTOT is the total relling moment. By assuming linear aerodynamics [1.e., LTOT = 43 + (LTOTES)], the equation of motion becomes

$$(1X)(PH1) + (3) + (1P)(P)$$

with the initial conditions, PHI - PHII and PHI - PHII at TIME - TIMEL, this equation can be integrated to give

PHI = P +
$$\left| \frac{\text{PHII}}{\text{PHII}} + \frac{\text{LO}}{\text{LP}} \right| = \frac{\text{LP}}{\text{CYIME TIMEI}}$$
 (2)

$$PHI = \frac{IX}{I.I'} \left(PHII + \frac{LO}{I.P} \right) \left[e^{\frac{I.P}{IX} \left(TIME - TIME1 \right)} - 1 \right] - \frac{LO}{I.P} \left(TIME - TIME1 \right) + PHII$$
 (3)

Equation (3) was fitted to approximately 200 points of roll position (PRI), time (TIME) data using a differential correction, least-squares technique to determine the constants LO, LP, PI, and PHII. Equation (2) was then used to calculate the roll rate. Numerous tare damping-data points were obtained (PT = 2050, 1000, 400, at V = 0) to evaluate the bearing friction. The rolling-moment coefficient at P = 0, CLO, and the roll-damping coefficient CLP are defined as

CLO =
$$(LO - LO_B)/QSD$$

CLP = $(LP - LP_B)(2V)/QSD^2$

where the subscript B denotes bearing.

The Magnus coefficients (CYP and CLNP) were determined from a linear fit of side force and yawing moment vs PD/2V for each angle of attack. The intercepts of the above data curve fits were utilized to shift the side-force and yawing-moment data through zero to obtain CYC and CLNC. Both the shifted data and nonshifted data were tabulated.

3.3 UNCERTAINTY OF MEASUREMENTS

3.3.1 General

The minimum accuracy of the basic measurements (PT and TT), based on repeat calibrations, were found to be

$$\frac{\Delta PT}{PT} = 0.0043 = 0.43\%, \frac{\Delta TT}{TT} = 0.0082 = 0.82\%$$

Uncertainties in the tunnel free-stream parameters and the model aerodynamic coefficients were estimated using the Taylor series method or error propagation, Eq. (4),

$$(\Delta F)^{2} = \left(\frac{\partial F}{X_{1}} \Delta X_{1}\right)^{2} + \left(\frac{\partial F}{X_{2}} \Delta X_{2}\right)^{2} + \left(\frac{\partial F}{X_{3}} \Delta X_{3}\right)^{2} + \left(\frac{\partial F}{X_{n}} \Delta X_{n}\right)^{2}$$
(4)

where ΔF is the absolute uncertainty in the dependent parameter $F = f(X_1, X_2, X_3, \dots, X_n)$ and X_n are the independent parameters (or basic measurements). ΔX_n are the uncertainties (errors) in the independent measurements (or variables).

3.3.2 Test Conditions

The accuracy (based on 20 deviation) of the basic tunnel parameters, PT and TT, and the 20 deviation in Mach number determined from test section flow calibrations were used to estimate uncertainties in the other free-stream properties using Eq. (4). The computed uncertainties in the tunnel free-stream conditions are summarized in Table 2.

3.3.3 Test Data

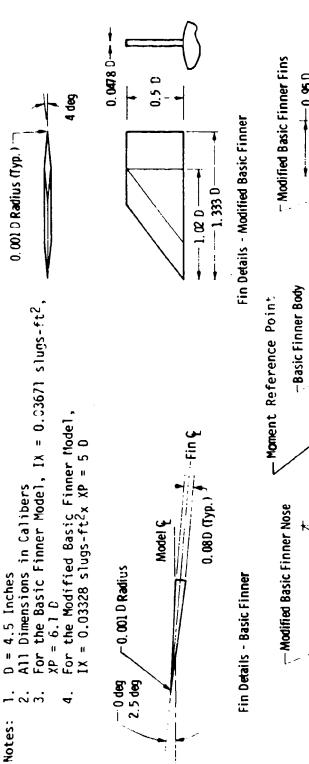
The balance uncertainties for the maximum calibration loads (see Table 3) given in Table 4 were combined with the tunnel parameter uncertainties using the Taylor series method of error propagation (Eq. 4) to estimate the uncertainties in the model aerodynamic coefficients (see Table 5). The accuracy in setting and maintaining a specified Mach number was ±0.005. The uncertainties in the model angle of attack and sector roll angle were ±0.1 and ±0.2 deg, respectively. The uncertainty in the model roll angle was ±20 deg and the uncertainty of model roll rate was ±2.1 radian/sec.

4.0 DATA PACKAGE PRESENTATION

The final data package included tabulated data, magnetic tape data, and installation and configuration documentation photographs. Comparison of the data with the reference 4T test results (AEDC-TR-76-58) are presented in Fig. 5. The data generally agree within the measurement uncertainty and therefore the comparison is considered favorable. A sample of the tabulated data is shown in Table \acute{v} .

APPENDIXES

1. ILLUSTRATIONS



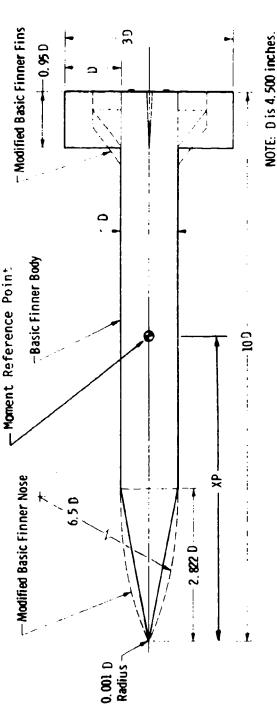
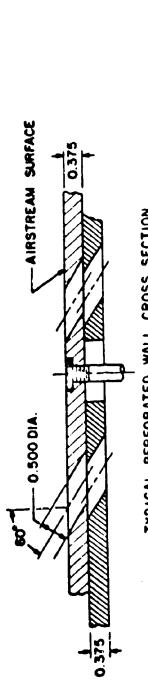
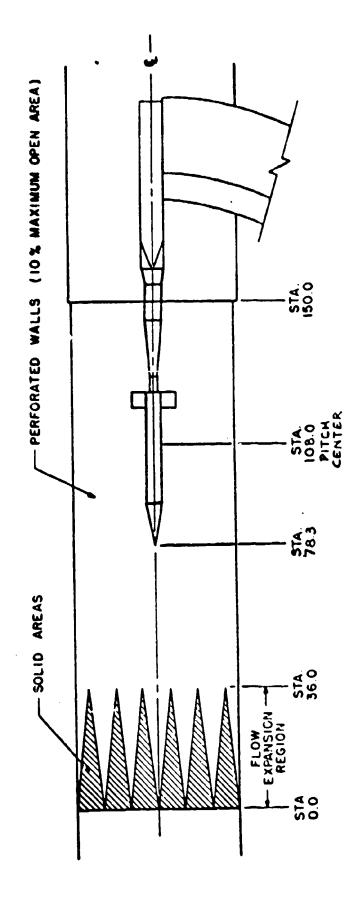


Fig. 1 Model Details

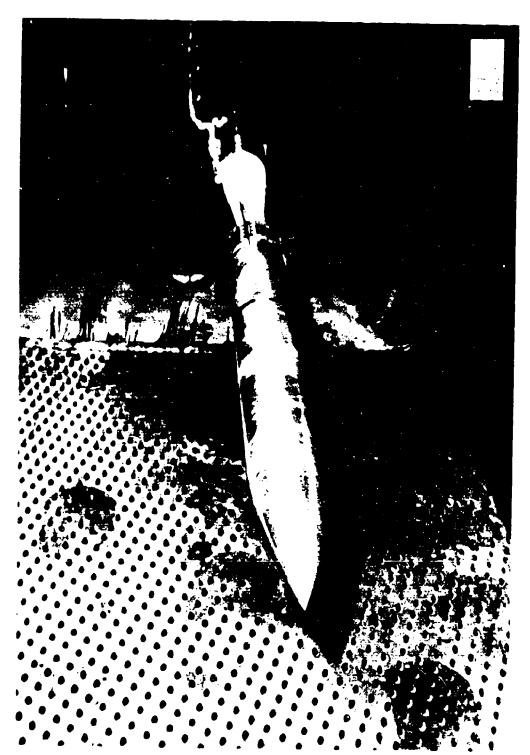


TYPICAL PERFORATED WALL CROSS SECTION

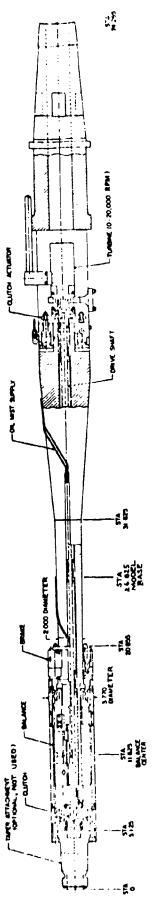


Profile Sketch (Basic Finner)

Model Installation in 4T F18.



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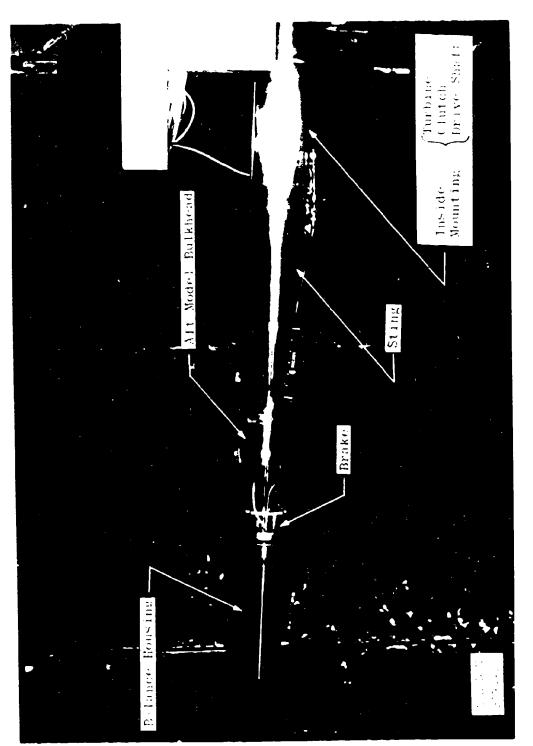


s. Profile Statch

3 High Alpha Roll Dynamics fest Mechanism

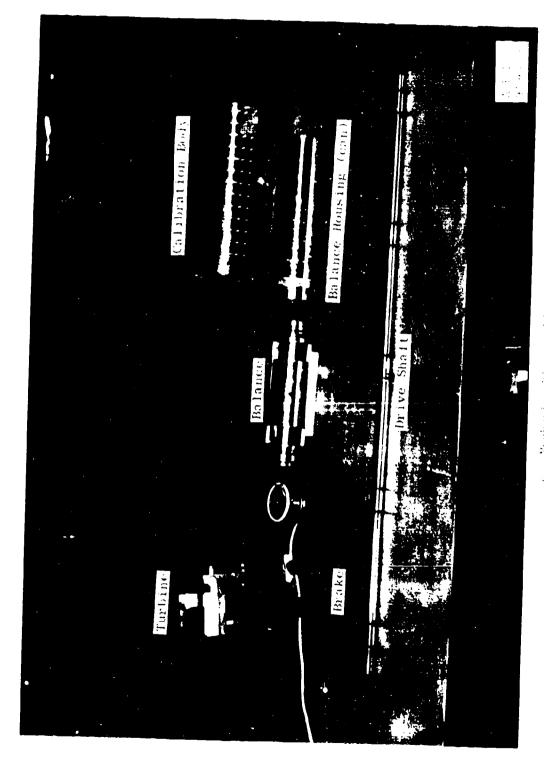
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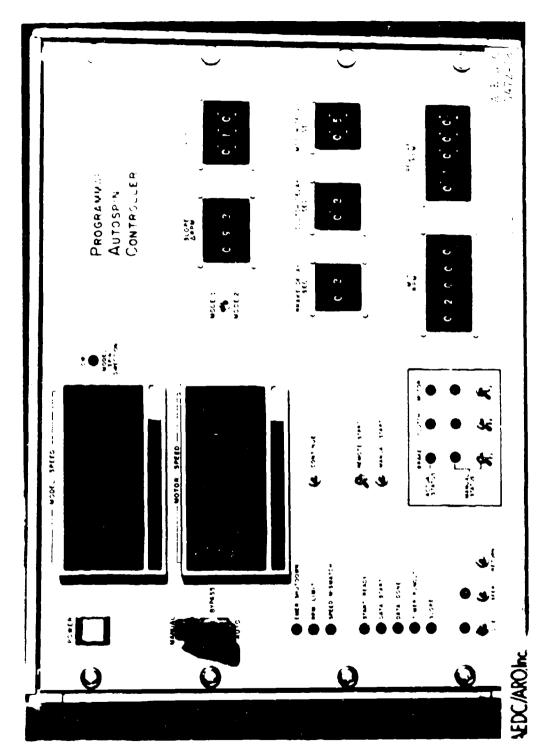


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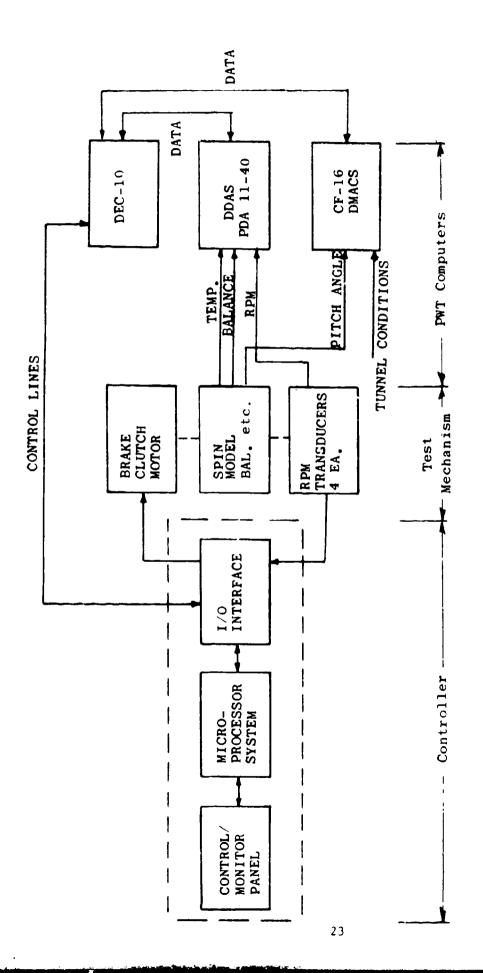


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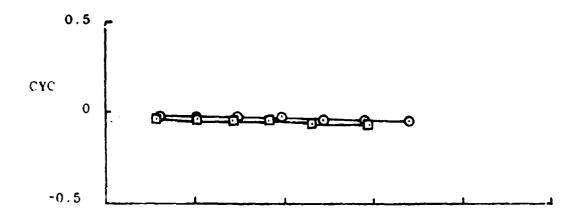
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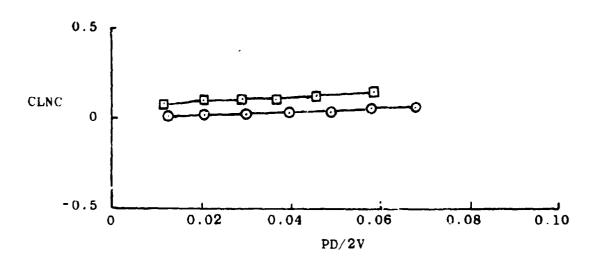
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b. Interface DiagramFig. 4 Concluded

Symbol	ALF-M	RED X 106	Data
0	10.32	0.41	Current
۵	9.97	0.41	AEDC-TR-76-58

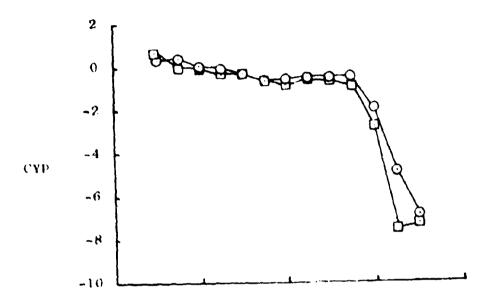


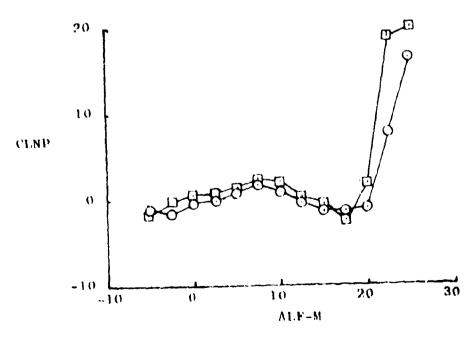


a. Modified Basic Finner, CYC and CLNC Versus PD/2V, M =0.90

Fig. 5 Data Comparison

Sym	RED X 10 ⁶	Data
0	0.41	Current
П	0.41	AEDC-TR-76-58

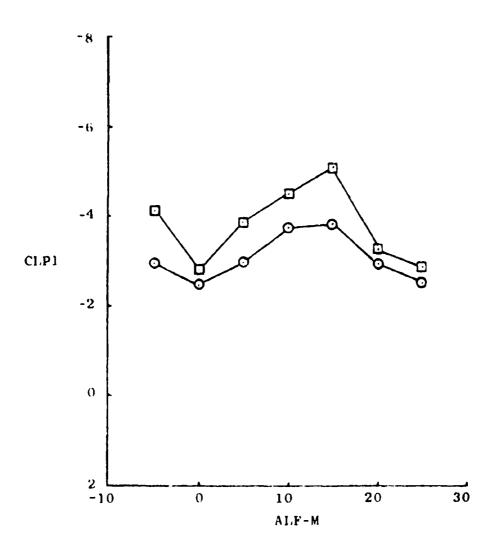




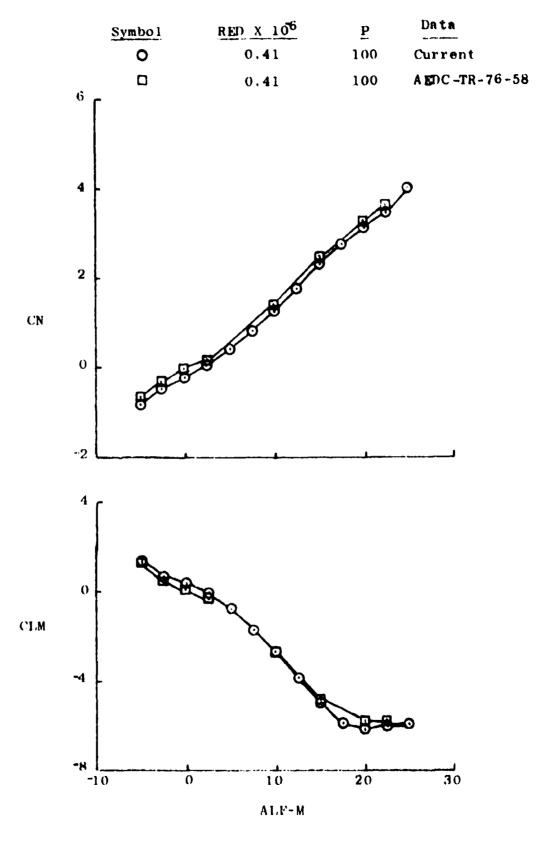
b. Modified Basic Finner, CYP and CLNP Versus ALF M. M = 0.90

Fig. 5 Continued

Symbol	RED X 10 ⁶	Data	
0	0.41	Current	
Ö	0.26	AEDC-TR-76-58	



c. Modified Basic Finner, CLP1 Versus ALF-M, M ~ 0.90 Fig. 5 Continued



d. Modified Basic Finner, CN and CLM Versus ALF-M, M = 0.90 Fig. 5 Concluded

11. TABLES

TABLE 1. TEST MATRIX SUMMARY

MODIFIED BASIC FINNER MODEL								
CONF	FIN	RED	R	MACH NUMBER				
	CANT	x 10 ⁶	X 10 ⁶	0.00(1)	0.60(7)	0.90(3)		
2	0.0	0.00	0.00	118-121*				
		0.26	0.70		124,127			
		0.41	1.10		131,132	134		
•	\	0.95	2.50			137,138		

BASIC FINNER MODEL							
CONF	FIN	RED X 10 ⁶	R X 10 ⁶	74	MACH NUM		
	CANI	10	1 10	0.22(4)	0.60 ⁽⁵⁾	0.90(6)	1.15
4 	2.5	0.10	0.28	148,149			
		0.41	1.10		168,169		
		0.75	2.00	156,157		163,164	166
+	•	0.95	2.50		159.161		

^{*}Part number

Notes:

- (1) RPM max = 6408, (V = 0, tare)
- RPM max -4966(2)
- (3) RPM max - 4364
- RPM mnx 353 (4)
- RPM max = 986**(5)** RPM max - 980 (6)
- RPM max = 1108(7)

TABLE 2 (±) ESTIMATED UNCERTAINTY IN TUNNEL TEST CONDITIONS For R 1.1 X $10^6 (\text{M} \pm 0.6 \text{ and } 0.9)$, and R=2 X $10^6 (\text{M} \pm 0.22 \text{ and } 1.15)$

Uncertainty *	MACH NUMBER					
	0.22	0.60	0.90	1.15		
ΔМ	0.006	0.007	0.007	0.005		
ΔQ	5.95	2.93	1.99	1.87		
ΔΡΤ	4.30	2,61	2.34	3.10		
ΔPl	4.33	2 .3 9	1.99	2.16		
ΔΤΤ	0.75	0.75	0.75	0.75		
Δν	7.3	7.7	6.4	4.0		

^{*}in the units of the parameter

TABLE 3
BALANCE LIMITS

Balance Component	Design Limit	Calibration Limit
Forward, Aft FNG, 1b	1200	500
Forward, Aft FYG. 1b	240	100

^{* 6000} RPM max for this loading.

TABLE 4
(+) ESTIMATED UNCERTAINTY IN BALANCE CALIBRATION

Balance	Type Gage	Loading*
Component, 1b	FNG	FYG
ΔFN	2.50	0. 4 6
ΔFY	0.44	0.29
ΔMM	6.43	2.03
ΔMN	2.14	1.01

^{*} Maximum calibration loading

TABLE 5
(±) ESTIMATED UNCERTAINTY IN AERODYNAMIC COEFFICIENTS

Parameter	ALF-M.		Mach Ni	amber	
	deg	0.22	0.60	0.90	1.15
ΔCN	0 20	0.375	0.296 0. 2 95	0. 220 0.216	0.105 0.106
ACY	0 20	0.078 0.080	0.063 0.062	0.045 0.045	0.022 0.023
ΔCLM	0 20	0.289 0.447	0,680 0,667	0.505 0.489	0.081 0.091
ΔCLN	0 20	0.089 0.094	0.116 0.117	0.086 0.086	0.0 2 5 €∀025
Δ(ΎΡ	0 20	0.820 0.275	0.066 0.372	0.282 0.696	0.207 1.074
ACLNP	0 20	0.188	0.165 0.185	0.122	0.043 0.820
&CLP1	0 20	1.229	0.353 0.327	0.308	0.342 0.406
ΔPD/2V	()	0.0007	0.0011	0.0006	0.0003

ARROLL	ARROLL ALREPO	PPO 104 WIND TOWEL AAROLU AIR FORCE STATION	ION. PERSESS	32823											
PART P	PART POINT PPOJECT		TEST 0	DATE 6	DAY WR WW SC 235 17439152	32 PB	NM 8C 0.005 B	NED NODE	ERCODE PRO	PROB DATE 21-0CT-78	WIND-OFF 122/ 2	FF AEBC	0		Towart
0.904	P. 254.9	186.4	326.6	BX10-6 AL	ALF! PHII	118-1 718-2 91.0 91.2	1.2 554.9	554.5	330.2 33	330.5 45	454.3 1.221	10.00	5.02 0.804	100 PM	16.3
CO3F	REDX19-0	6 PELX10-6		V FEN	30		15	3. C1	C BOX6		10.00	A.50	XP 22.500.0.	1X 03320	CPAP.
. SAMPLE	•			1864	Cx	CLM	ž	£1.1	110	XCD	XCP		PWI	j	LICI
	7	0.084	*	=	-0.9243	1.99.1		-0.16952	120	-2.1175	-4.	00	503.7	-5	.6546
:	4.99	0.0769		3952.	0.9184	1.9215	0.03761	-0.17173	0.6280	2.0924 -2.0639	į	9145	710.2		-2.3979
	66.11		377.	3600	-0.9029	1.9494	0.03575	707	-	-2.0405					.2789
	66.4.	00		3437.	-0.5896	1.8050	0.03541	-0.16439	1.1280	-2.9293	? 1		0.96.1	•	.1712
		10	l	; = 	0.9753	1.7346		-0.17019	1.6289		-5.6		1069.5		910
-	•	•		~	-0.0678	1.7102	٥.	-0.16806	1.8780	11.6.1-	15.75	545	1109.3	-	. 179
- 5	66.00	٠,	249.1	2856.	0.05.39	1.6994	0.03495	-0.16733	2.1280	1.9560	9 (\$ 00 ×	1225.6	77	
		•	i		-0.8649	1.6593	0.03147	-0.16641	2.6290	916			0.094	-	644.
	7	١	- 1	7	-0.9551	•	-00180.0-	7	9				134.5	-	525
2:	7	40.0		23.6	17 S. C.	* *	0.03056	-0.15495	3.1280	1.9848	# · ·	780	1497,9	77	4936
			1	7117		1.5906	3	-0.15691	3,6280	-1.869			1616.4		1.3599
37		0.0421	215.7	1.70	-0.0439	1.5712 -	0.02905	•	3.8787	-1. 630	•;	568	1671.0	1	1.3000
-		0.040	207.0	977	-0.6413	1,5552	0.02411	-0.15207	4.1287	-1.6407		9 6	724.0	7 7	-1.2310
32		0.0		1004		1.5239	0.02627	-0.14770	4.6285	1.034	7	67.9	023.2	-	1357
<u>ک</u> ا	7		•.	-1723	-0.292	1.5192	0.02424	-0.14153	- 4 R 7 R O .		-21.3	23	2.69.2		0676
2 2		0.032		1572	-0.9755	1.43.5	0.02536	-0.13995	5.1780	0678.1-		979	1955.2	- 9	96.66.0
≈:	•	0.9306	-	1503	-0.8232	•		-0.13750	628	_	.5.5		995.2	0	0.9713
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97	60.1-9	0.0247			-0.9219	1.460)	0,610.0	• ~	6.3780	-1.7892			2105.1	٦	6393.0-
~	66.90	0.0254		1249.	-0.8291	1.4630	۰.	250	6,6280	-1.7873	~		2130.5	9	-0.7923
2 2		6 6 6 6	1	1192	-0.F216	4500	6.019.5	-0.12259	7 1279	-1.7815	2011		2250.3		-0.7133
. 9	•	0.9221	- 1	1047	-9.9148	155	64,10.0	-0.12044	פרונינ	1.7920	•		2229.	0	£089.04
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	66.1	2025.0	200	7	1216.0-	1.4422	0.01763	159	7.9779	-1.7755	,	1616	2284.1	9	-0.6153
7 6	•	0.0194	•	006	-0.40B	1.4286	0.01669	-0.11162	0.3779	1,7741	-10.2		2333.5	9	-C.5796
2	6.4	0.0176		3	-0.0038	1.4232		-0.10987	6.6219		,		2356.6		-0,5248
3	6.	9	5	825-	-0.1142	1.4298	0	0	2	-1.7614	7		2379.6	•	-0.5456
	60.	0.0153	78.0	751.	-0.8049	1.4178	0.01429	-0.10297	9.3779	1,771		. •	2419.7	•	
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17.	6.087 6.786	X	121	*00000°	100									
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### ##################################	### ##################################		POTET		PX10-6	IZNJES AC	33.	JEO						
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### ### PD/24 CYC CLMC #################################	### -1.06401 0.01137 -0.09972 6.785g-08 ###################################	٠				-	!	-						
#### ### ### #########################	#### ### ### #########################	CY 20	ì	CLNP	7	- 1	CENO	İ						!
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4.99 413.9 0.01005 0.0240 0.0000 2.661 4.99 372.0 0.0700 0.0244 0.0100 2.601 4.99 343.5 0.0700 0.0244 0.0100 2.601 4.99 343.5 0.0638 0.0244 0.010 2.603 4.99 343.5 0.0638 0.0241 0.0106 1.706 4.99 225.0 0.0537 0.0237 0.0583 0.0272 4.99 226.4 0.0557 0.0237 0.0583 0.0107 4.99 226.4 0.0557 0.0108 0.0563 1.416 4.99 227.0 0.0441 0.0107 0.0592 1.416 4.99 227.0 0.0441 0.0107 0.0593 1.416 4.99 372.4 0.0347 0.0177 0.0533 0.0177 4.99 372.4 0.0347 0.0177 0.0533 0.0177 4.99 372.4 0.0347 0.0177 0.0533 0.0177 4.99 372.4 0.0347 0.0177 0.0533 0.0177 4.99 372.4 0.0347 0.0189 0.0272 0.061 4.99 372.4 0.0347 0.0177 0.0533 0.0177 4.99 372.4 0.0347 0.0177 0.0533 0.0177 4.99 372.4 0.0347 0.0177 0.0533 0.0177 4.99 372.4 0.0347 0.0177 0.0277 4.99 372.4 0.0277 0.0277 4.99 372.4 0.0277 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0277 4.99 372.4 0.0177 4.99 372.4 0.0177 4.99 372.4 0.0177 4.99 372.4 0.0177 4.99 372.4 0.0177 4.99 372.4 0.0177 4.99 372.4 0.0078 4.99 372.4 0.0078 4.99 372.4 0.0078 4.99 372.4 0.0078 4.99 372.4 0.0078 4.99 372.4 0.0177 4.99 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.0077 4.90 372.7 0.00	4.99 413.9 0.0103 0.0246 -0.0100 2.661 -0.092 0.	<u>.</u> .	_ ,	• :		12/	ָב בע	ರ	ŭ	76.8				
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